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Mentality
Measurement and Representation

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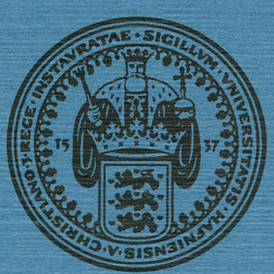

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Abstract

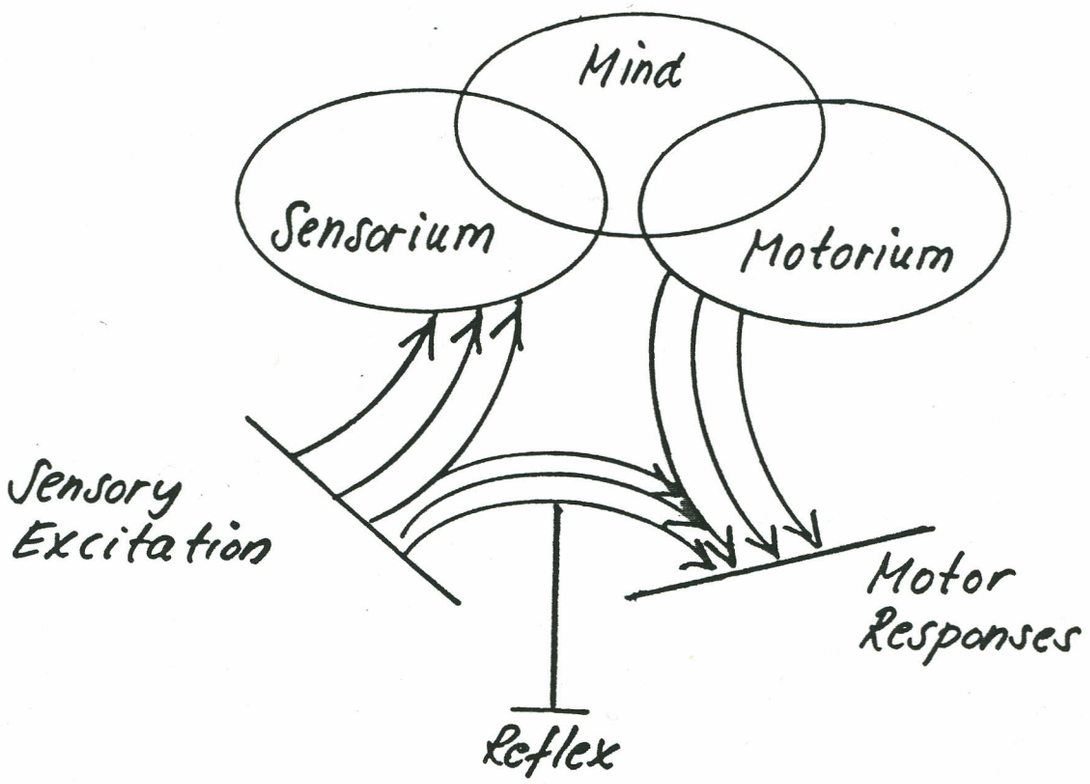
The scientific treatment of the concept of consciousness is multifarious. This has caused a number of different approaches. The present articles gives some introductory account of the research on consciousness. However, the main hypothesis advanced is based on the premise that consciousness emerges from the cooperative interaction of multiple agents and agencies within naturally produced text. By means of Perspective Text Analysis it is demonstrated that the Kantian schema provides the necessary foundation for making explicit the teleonomic component governing natural language production. Thereby, the concept of text is redefined such that textual transformation and recursive restructuring become their meaning in relation to the concepts of textual dynamics and linkages. Its configurational architecture is demonstrated on the basis of the (AaO) formula. As a result the entirety of structural relations evolve as a double helical structure. Both have been analyzed within the framework of differential topology in order to demonstrate the necessity of cooperating perspective and objective structures in establishing perspective and objective invariance.

Subjective Consciousness

The concept of subjective consciousness is multifaceted. This has caused a number of different definitions (see Natsoulas, 1983). In his discussion of consciousness, Hebb (1980 p. 20) argues that the concept is used primarily to indicate the state of alertness of a normal adult person. With alertness it is meant the individual's capability to adapt to its environment. In this sense, the concept is equivalent with awareness, meaning the social or joint use of abstractions gradually refined through the discourse emerging through speech.

Being aware of something implies an integration of persons, objects and events into significant conceptualizations, often expressed by 'it'. As is obvious from the scientific discussion, consciousness was considered to represent an attribute of matter ('it'). In the beginning of psychology as a science some researchers insisted not only on the associate relation between brain and behaviour as depicted in Figure 1, but also on an adequate measurement and representation of the immaterial Mind (Pribram, 1969, p. 60).

Figure 1. Relation of Mind to Brain in the Cartesian Nervous System (Bell-Magendie Separation)



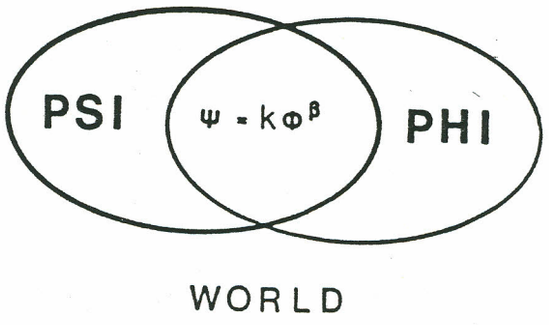
Relation of Mind to Brain in the Cartesian Nervous System (Bell's Separation)

As is obvious from Figure 1 the Cartesian nervous system has been separated by means of the Bell-Magendie law (Hebb, 1980, p. 32). It stipulates that the ventral roots of the spinal nerves carry the motor function of the cortex while the dorsal roots apply to its sensory areas. Furthermore, the S-R link represents the "reflex". The reflex has its own built-in cross-connections. These are generally conceived to be unidirectional in kind. The entire information transfer from the transmitting unit cell to the recipient cell consists of electrical impulses as its carriers. However, in many cases bidirectionality based on different connections each leading in an opposite direction has been observed (Konorski, 1969, p. 307).

Though, the establishment of empirical research on the mind and its behavioural consequences requires a focus on the quantitative aspect of the mind to brain relationship. Subjective consciousness refers to the phenomenon of introspection. It comprises a person's ability to look inward with the purpose of examining internal stimuli and mental processes. In a sense, one may be aware either of one's sensations and feelings or relational thoughts, i.e that something is the case. By focusing on careful framing through training of observers and systematic control of the attributes of stimulus material, introspectionists have tried to give evidence to the existence of subjective consciousness. To them it appeared that mental content is made up entirely of sensations and images (internal arising sensations). Consequently, Brentano's (1838-1917) proposition:

If variability is measured in the same scale unit it follows that variability, measured in subjective units, is linearly related to its psychological magnitude, was investigated on the basis of the model depicted in Figure 2.

Figure 2. Psychophysical Model for Scaling Mentality



Psi = World of Experience
Phi = Physiological Processing of Reflected Energy

Because the mental and physical dimensions are conceived as identical in structure, the discrimination of a sphere pertaining to sensation and feeling immediately makes possible psychophysical scaling. In the psychophysical approach to measurement and representation of consciousness, it is of fundamental importance that the observer's frame of mind about his judgments can be controlled experimentally. It follows that

the sensory content of the objects of the physical and social world for that matter can be measured in terms of their mental or psychological values. Weber's (1795-1978) law concerns just this growth of variability in the judgment of a stimulus attribute (X_i) when growth is a function of stimulus measurement.

Fechner (1801-1887) and later Thurstone (1887-1955) contributed with the assumption of the importance of a sensitivity integration. They showed that variability between subjective units is constant within a certain psychological continuum. The most general expression, namely that sensation magnitude (psi) grows as a power function of the stimulus magnitude (phi) has been achieved by Stevens (1906-1973) and has become known as Stevens' law (Stevens, 1978)

In terms of the formula in Figure 2 it means that the constant (k) of the expression depends on the units of measurement. Therefore, it is of minor interest. What concerns the psychophysicist is "the value of the exponent which serves as a kind of signature that may differ from one sensory continuum to another" (Stevens, 1978, p. 13). The structural identity proposed between the world of experience and the world surrounding the individual can be given a logarithmic expression which eliminates all bending of the curves:

$$\text{Log(psi)} = \text{beta (log(phi))} + \text{log (k)}$$

This formula describes a straight line in log-log coordinates, and the exponent (beta) becomes the slope of the line and consequently, the only significant expression. Both (psi and phi) have been conceptualized as coordinated phenomenological forms of actions and events that can be investigated by the methods of psychophysics.

It might often be appropriate to formulate psychophysical laws upon the power function. But "any interpretation is totally dependent on the assumption that the response measure is valid. Otherwise, the power function is no more then a regularity in response bias" (Anderson, 1981 pp. 337-338).

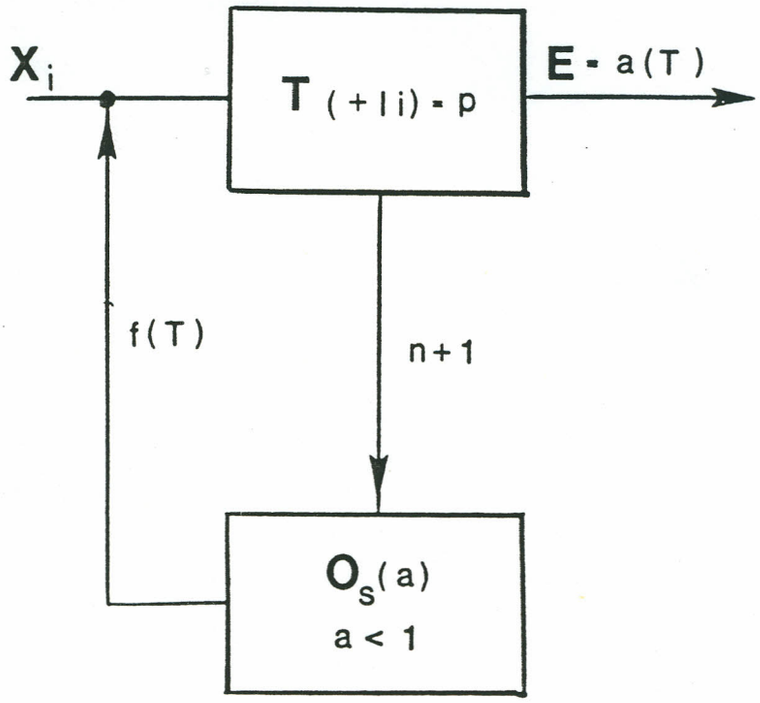
Mental Test Scores

The important task undertaken by psychometricians (Lord & Novick, 1968, p. 1) was "to provide explicit syntactic (i.e, mathematical) definitions for concepts having semantic (i.e, real world) significance". The authors give their basic definition of mental test scores in the form of a Figure (p. 17) which is equivalent to the model depicted in Figure 3. This model has been proposed by Miller, Galanter, and Pribram (1970, p. 34). It represents a change in response probability, and thus a behavioural or interactive definition of mentality.

The model implies a substantial differentiation of cause and effect. The special function of a causal interaction provides for learned connections between the variables of investigation (X) and the measurement of event-related potentials. The number of times a particular item (i) has been processed determines completely the state of the "learning system". Initially, the system processes a given item on the basis of some a priori probability of error. Thus, item (i) is connected to some test characteristics (T) such that the probability for correctly processing item (i) is given by a not necessarily reversible function:

$$f_i(T) = (p+ i,T)$$

Figure 3. Cybernetics of Information Integration



In organizing perceptual and motor processes the item (i) is recursively processed. In each successive run its error probability is reduced by a factor a, where a < 1. The modification of the learning state of the system is essentially based on the difference or incongruity principle. This means that the probability of an error on the (n + 1) run is related to the probability on the nth run. Formally, this results for person (j) in the following logistic function:

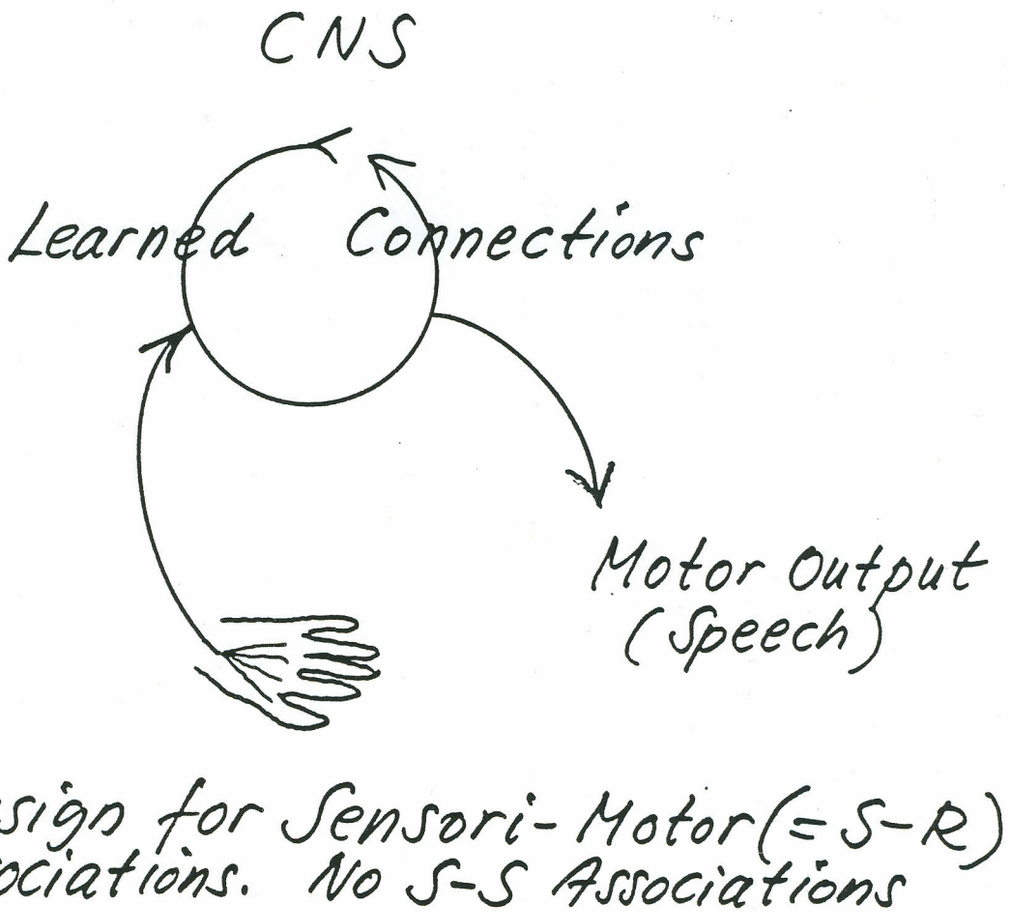
$T(+ j,i) = aT/1+aT.$

Any person with this test value (T) has the same chance ($f_i(T)$) to process item (i) correctly. Consequently, mentality is now behaviourally explained as the result of a gradual reduction of error probability through recursive processing. This function produces a "characteristic item curve" (Lord & Novick, 1968, p. 366).

Each species, however low on the systematic scale, shows behavioural expressions that include numerous details pointing toward learning (Immelmann, 1979, p.121-133). Certain nets of neurons are assumed to carry a decision function. They are used for transferring activity and to decide on which of two activities should be carried out. Thus, behaviour is equated with the physiological representation depicted in Figure 4.

In Figure 4 behavioural response potential is explained in relation to the neuronal network as basis of a nervous testing mechanism (Konorski, 1969, p. 308).

Figure 4. Design for Sensori-Motor (= S-R) Associations. No S-S Associations are Assumed



As a result, consciousness has now been totally removed from empirical measurement and representation. The TOTE model differentiates between sequences of events and consequent information processing. No provision is made for any independent activity. Moreover, this postulated internal flip-flop mechanism relates the behavioural response of the organism to electrochemical (or biochemical) balance theories. It follows that dominant patterns in the neuronal net are directly related to action, implying that the cause of behaviour is implicit and consequently insensitive to changes in the environmental context. To summarize:

"Mentality" is a Function of a **Dominant Pattern** plus a **Causal Control Potential**.

However, these action patterns are theoretically empty, because information flow has been defined within a strict S-R framework and thus, in terms of associative networks. Its related logic is insignificant for an understanding of human information processing and shows only limited usefulness as instrument for computer simulation. "Computer molecules" cannot really be compared to natural cell assemblies. Their purpose is to "act" on command like a switch to determine whether a nerve cell will or will not participate in a network.

Intentionality as Mark of Mentality

With more information having become available it is now apparent that the intention of the individual defines its scope of action. But to fulfil the development of genetically encoded patterns of behaviour, especially during early stages, "telotaxis" has to give directiveness to "intentional movements" (Hess, 1970, pp. 44, 54). This is the function of focusing in the orientation toward objects and events. To make this insight apparent and to stress the evolutionary character of inherited behaviour it is necessary to anticipate brain processes that are self-referential and that operate on self-constructed criteria. Making these processes measurable depends on one's ability to discover transformations for its precision. By specifying the transformations involved in moving from one state to another allows for a scientific approach. The brain's evolutionary structure is assumed to determine the state dependencies of the components carrying intention and orientation respectively.

Genetic epistemology (Piaget, 1978) and developmental psychology (Werner & Kaplan, 1963) as well as analytic biology (Sommerhoff, 1950; Wolsky & Wolsky, 1976) have demonstrated that the general cooperation of the individual with its environment requires the teleonomic concept in order for the individual to express an "intended" and "oriented" schematizing. Monod (1971) assumes that all behaviour is "teleonomic" inasmuch as behaviour is directed towards the environment. Further, observing behaviour in language is hardly possible without a model and a procedure for schematizing, because observation presupposes not only that a structure can be specified but also that intentionality and orientation can be observed. In order to get hold of the intention it becomes necessary to apply the Schema concept to the observation.

What is missing in the current approaches toward the study of mind is an understanding of the relationship between proximal and final causation of these components as well as their relationship to transformation. The only way of directing a respectable inquiry into the development of brain processes is a modeling of these by studying natural language production with a Kantian approach. Therefore, the main thesis advanced in the following is based on the premise that information processed in absence of natural language is inaccessible to the mind, because the asymmetries and discontinuities in natural language production are reflecting various degrees of human consciousness. Consequently, the brain as self-referential system becomes only accessible through the dynamics and linkage relations manifested in natural language expressions.

At the moment of text production the dynamics and structure of the original events become part in the development of a course which has to be measured and represented topologically. This may be done by observing how the action component of the (AaO) formula becomes realized in natural language. By binding its values with respect to the complementary role of the A's and O's all possible events can be represented in binary matrices. In the course, both structure and process are modified through successive contributions of new linkage relations formed or broken within a Phase space. Characteristic of the A-function is that it must always be distinguishable and the empirical context be known. On the basis of the original structural information necessary for the development of consciousness it will be possible to bring about the teleonomic component governing language production.

This may be illustrated with a verbal expression taken from an interview about municipal economics presented in Bierschenk and Bierschenk (1986 b). The text of concern to the present analysis is the following (the translation from free flowing

Swedish is literal):

Natural Text Discourse

Titta på hur inställningen är idag och det är
Look at how the attitude is today and it is

ju inte bara bland de kommunalt anställda,
you konw not only among the municipally employed,

de flesta tycker ju att jag har ju min
the majority thinks you know that I have you know my

lön, varför ska jag då hjälpa till med att komma
salary, why shall I then help (to) with finding

på hur kommunen ska spara, det skiter
out how the municipality shall save, that don't care a damn

väl jag i. Det är samma resonemang här, ...
surely I about. It is the same reasoning here, ...

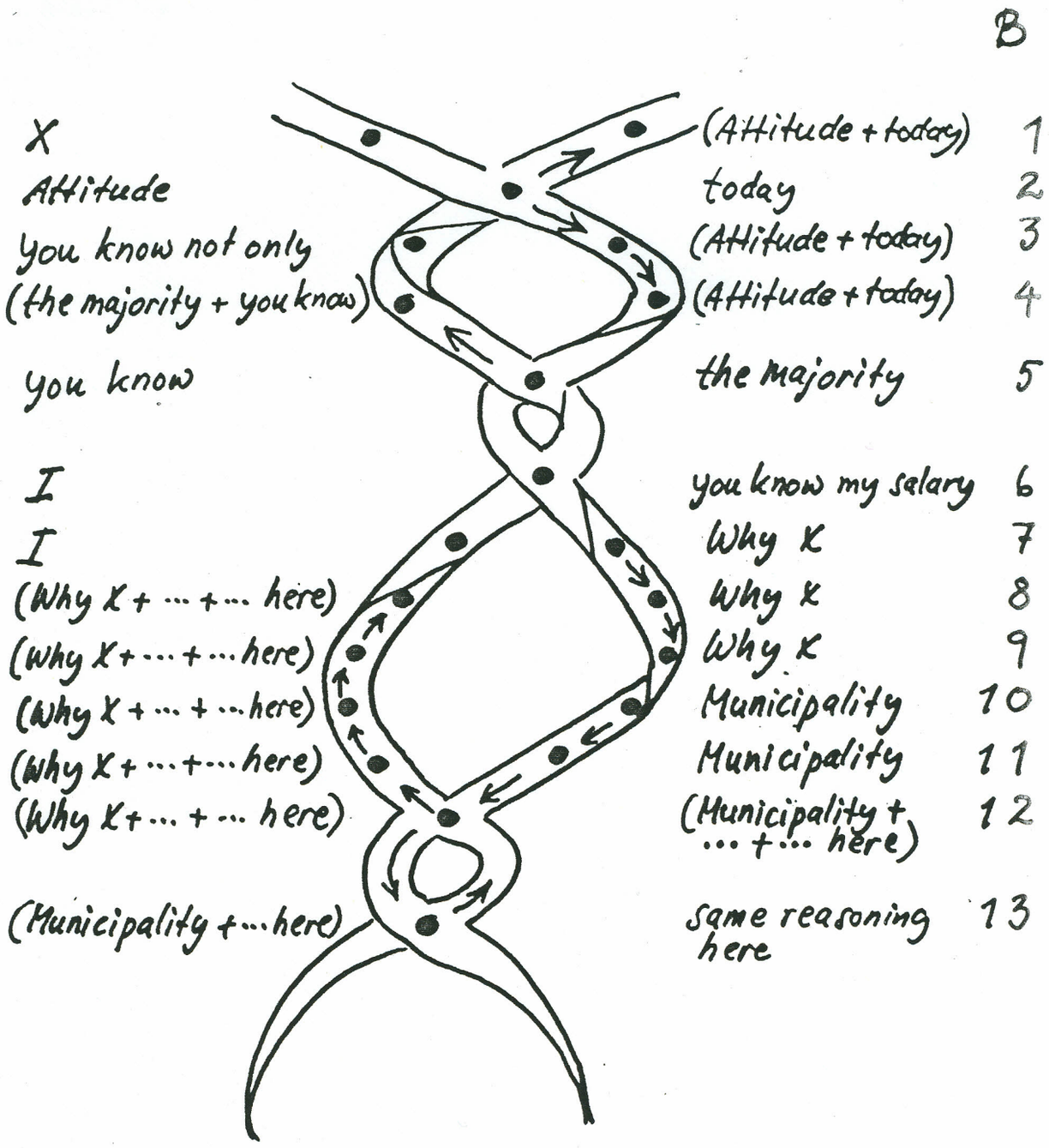
The rules and procedures for processing this text have been presented in Bierschenk & Bierschenk (1986 a, b). Processing the text manifests the application of Perspective Text Analysis operationalized in the form of a package of computer programs written by Helge Helmersson (1991). The process of abstracting the structural and organizational aspects of natural text implies that all letters or strings of letters are identified and tested for their distinctiveness.

The Double Helix in Language

It is possible to observe the architectural configuration and transformations of cooperative working structures by introducing a nominalization process. Nominalization implies that integrations can be processed with the aim of demonstrating the topological invariants of covarying structures. By analyzing the given part of the interview text on the basis of the Schema assumption it will become possible to demonstrate some fascinating intertwined structures, one related to intention (i. e. perspecitve) and the other to orientation (i. e. objective). In the following, the mechanism governing the intentional use of language will be described by demonstrating its working. Later on its implications are followed up by means of the topological analysis of its outcome. Thus, it is the structure embedded in the Schema formula that makes use of the dual steering and control mechanism exerted by the A's and O's of the expression. By modeling and unfolding the formula into a system, as demonstrated in Figure 5, a verbal string has been defined as a conceptualization whenever all three constitutive components of the (AaO) formula are present. If this is the case, the strings are renamed and counted as Block (1, 2, ... n).

The operating process causing the course of development is visualized by a moving point. Its upward moving results in a supplementation of the place holder for the objective (Aa(O)) while the complementary move implies a supplementation of the place holder for the agent ((A)aO). Supplementation and substitution is carried out

Figure 5. Imposition of Form on Consciousness: Schematic View of the AaO produced Configuration built up from Natural Text Discourse.



by a routine that transfers strings of letters from one segment of the unfolding structure to the next ensuring the preservation of structural identity in the configuration.

The development gives expression to an unknown agent's (X) orientation toward a yet unknown environmental phenomenon. In the context of Figure 5 the first transformational stage is reached at the point where both curves meet (Block 2). This

Block plays a critical role in that both structure and process are modified through the conceptualization it represents. Successive contributions of new textual information is indicated by Block (5). This Block makes up the second transformational stage which also contributes to the first segment of the configuration. Obviously, the strings of the agent component are copied down two steps (Blocks 3 and 4), while the conceptualized objective moves upward by one step. A third transformational stage follows immediately (Block 6). Thereafter, the unknown agent (X) reappears. It is introduced by a wh-question and governs the process three steps onward. Within the boundaries of the fourth transformation, municipality as agent takes over and becomes part of the conceptualization of the objective (Block 12). Then, this objective moves upward four steps. Most interestingly, a self-referential loop is reached in the example (Block 13). It is a natural place for cessation and termination of the intended demonstration of the cycles and asymmetries involved in the recursive restructuring of text development.

The asymmetrical relations between agents and objectives constitute the foundation of the developmental control over textual differentiation and integration. The mechanism binds the agent and the objectives to each other. The differentiation process rests on variable measurement and thus on the viewpoints that are focused to varying degree. The integration is represented by the conceptualizations presented with parentheses. This cooperative process of agent and objective makes "knowing together" the outcome of an ability to transmit the effect of experience through the (AaO) mechanism inherent in language production.

What exactly has been achieved by this dynamical mechanism is the generation of a process that unfolds a three-dimensional structure in accordance with the analytic content of human expressions reflected in natural language. The arrows and gates of Figure 5 give the description of the dynamics and linkages in the verbal flow. They show the dependencies of the expressions and demonstrate the procedural control of discontinuity and transformation. The way in which clauses and phrases cooperate and interact defines the corresponding structural unit. Textual transformations and changes in the representation of an observation are abstract phenomena, but they are still the prerequisites for algorithmic processing and the detection of the structural nature of an observation. But the entirety of relations making up the structure of a text is far too complex to be comprehended without the aid of a topological analysis.

Topological Representation

The dynamics of the text generates and modifies the existing linkage relations. From a structural point of view it is sufficient to determine the relational affinity between the agents and the objectives of the text which is defined by the verb-function. As a first measure the agents were defined as variables on the basis of which the viewpoints of the objective component were grouped. The viepoints and groupings have been analyzed by means of the agglomerative procedure developed by Ward (1963). His goal was to minimize information loss during the process. With the purpose of finding the pairs or groups which in the process result in a minimum possible increase of the Error Sum of Squares (ESS) all possible unions are utilized. The actual calculation has been carried out with a package of computer programs developed by Helmersson (1991).

On the basis of the cycles in the information flow two natural groupings were identified which is synonymous with the definition of the states of that system:

Cluster 1: Non-Performance
idag (today)
ju (you know)
ju min lön (you know my salary)
kommunen+ väl jag i+samma resonemang här (municipality+well I in+ same reasoning here)
väl jag (well I)

Cluster 2: Opinion
2 ju inte bara (you know not only)
3 de flesta+ju (the majority+you know)

The first cluster represents the second segment of the unfolding O-curve, while the second cluster represents the viewpoints of the first segment.

The prototypical naming of these clusters abstracts the experience and imaginations from the strings of symbols conglomerated within the respective cluster. The result are the analytical concepts whose names are determined by words and symbols making up the clusters. But more important is that their structured configuration can be observed. From a formal logical point of view the heaviest concentration of strings determines the starting-point of the transformational process. The way in which the states are linked give rise to a developmental course characterizing the dynamics of the original text. In the present context the dynamics of the process and its constraints have generated **one** synthetic concept:

Laissez-faire Conduct

This concept has not to be conceived of as integrations as exemplified by the prototypical names of clusters but as a topological invariant and consequently, as the beginning of a network of terms.

The topologically defined invariants are points where two relations bifurcate. Any time a bifurcation can be observed, it points toward some discontinuity in the conceptualization. If the changes are small, a stable oscillating process produces a path. When continuous changes in the independent parameters evoke discontinuity, this can be represented as a singularity. Any singularity that can be established at a particular moment in time defines at that moment the highest point of the unfolding curve. Thus, a singularity exists as a topological invariant independently of the kind or degree of deformation the curve is exposed to.

Discussion

The "language-context" dichotomy is both the most fundamental and the most functional dichotomy with respect to the cerebral hemispheres in man (Cook, 1986, p. 147; LeDoux, 1984, p. 206). This implies in the first place that language needs to be treated as a medium with and through which the consciousness of man gets its expression and in the second place as means of communication. Only under the condition that verbal communication can be made the point of departure for exactness in the measurement and representation of mental processes can consciousness be approached with scientific rigour.

Consciousness prerequires a responsible agent, i.e a person having the ability to be cooperative in his interaction with his environment. Without this ability of estab-

lishing self-referential relationships no consciousness can arise, because 'con' (with) and 'scio' (I know) means knowing with others. Thus, consciousness gives expression to the 'I-you' relation being fundamental in organizing and reorganizing basic interpersonal relations through speech. In this respect consciousness has to be considered of as being the result of a mental effort which any individual of any generation has to achieve anew.

Consciousness arises only under the condition of a language that generates an operative space within which the textual agents can act. By that, consciousness as a mental phenomenon controls the discourse on narration of alternative behaviour and behavioural consequences. The configurational characteristics of the evolving structures exert causal control functions. In this process language reflects this decisive control potential that ties the "knowing" subject to the "knowable" object or event.

It follows that consciousness emerges as a novelty from the cooperative interaction of multiple textual agents. Every agent contributes with its specific intentions to the materialization of a verbal flow into text. The prototypical properties emerging from the grouping of the textual agents represent structural similarities with properties belonging to the agents of a certain group. Moreover, by the coherence in the relationships multiple textual agents are tied together into agencies. These are in turn recursively grouped and the affinity relations underlying the groupings create the conditions from which the properties of language as a system for expressing consciousness arise.

It is important to systematize the ways agents and agencies are interacting and changing throughout a text. A set of agents can be observed to cohere and interact in such a way that their attributes define the nature of the system. Clustering shows whether and to what extent the established groups have created state properties that alone can manifest itself through topographical representation.

Synthetic concepts, more or less embedded in natural language expressions, are the result of the discovery of the steering and controlling function of the Agent component. The established mechanism can only be discovered if the construction of language expressions gives space for the symbolization of the I-function. Language marks the difference between consciousness and self-consciousness (Eccles, 1980). Self-consciousness appears when individual variations can be comprehended in that I-me and you-me relations can be synthesized into an I-function and communicated through language. Therefore, self-consciousness develops only under the condition that a metaphorical "I" can operate in language. When this function is concealed or non-detectable in verbal behaviour, it deprives us of the possibility of knowing what is symbolically expressed. Moreover, if there is no discoverable I-function, a verbal expression cannot be recognized as an intentional act, and logically, cannot serve its purpose of providing meaningful information either. Both the non-dominant and the dominant hemisphere have the ability of perceptual awareness of sensations. But with reference to the I-function, it is only the dominant hemisphere that reacts cognitively (Sperry, 1966; Sperry, Zaidel, and Zaidel, 1979). If the dominant hemisphere shall be able to conceive "the I" of a unique being, it is necessary that the intentional component of language is perceivable, i.e language must be recognized as a self-referential system.

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